Summary of the Effects of Feeding Macerated Alfalfa Silage to Lactating Dairy Cows

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Introduction

Improving the energy content of alfalfa forage would increase its value to dairy cows because less concentrate would need to be fed to maintain performance. A number of small trials conducted at the Dairy Forage Center showed that macerating alfalfa concurrent with mowing improved ruminal fiber digestion. Work has continued on the maceration-mat machine; four large scale feeding studies and one smaller digestibility trial were conducted during the past two years to assess the possible benefits of maceration on the utilization of alfalfa silage. This report summarizes the findings from these recent studies.

Materials and Methods

Alfalfa was harvested using either a conventional mower-conditioner (Control) or the prototype maceration-mat machine (Macerated), field wilted to 40 to 50% DM and ensiled in upright concrete stave silos for three cuttings during 1996 and for two cuttings during 1997. One digestibility trial (third cutting) and two lactation trials (first and second cutting) were conducted with alfalfa harvested in 1996; two lactation trials (first and second cutting) were conducted with alfalfa harvested in 1997. A total of 141 cows were used in the four lactation trials. Apparent digestibility of DM, OM, NDF, ADF and CP was determined using both external (Yb) and internal (indigestible ADF) markers in the digestibility trial; apparent digestibility was determined using the internal marker only in all other trials. Three diets were fed in lactation trials: Negative Control (control alfalfa) and Macerated (macerated alfalfa) diets were formulated with about 60% DM from alfalfa, and Positive Control (control alfalfa) with about 50% DM from alfalfa (Table 2). Cows were fed their diets for 10-wk without switching in lactation trials conducted using 1996 forage; cows were fed diets in 3X3 Latin square arrangements of treatments (4-wk periods, 12-wk total) in lactation trials conducted using 1997 forage. Cows were injected biweekly with rBST; intake, milk yield, and BW changes were measured in all lactation trials. The general linear models procedure of SAS was used in the overall statistical analysis by weighting performance responses by the number of cows in each trial.

Results and Discussion

Overall, CP content and pH content of Macerated alfalfa silage were similar to Control; however, Macerated alfalfa contained greater amounts of ash, NDF and ADF (Table 1). This suggested that more soil contamination and possibly greater leaf loss occurred when Macerated alfalfa was harvested for our studies. The 8% reduction in NPN in Macerated alfalfa suggested that its fermentation was more rapid; this would be beneficial to CP utilization by the cow. The mean composition of the diets fed in the four lactation studies (Table 2) indicated that the Negative Control and Macerated diets were nearly identical, except for the source of alfalfa silage. Also, it should be noted that the Positive Control diets contained about 7 percentage units more high moisture corn, 3.6 percentage units more soybean meal, plus sodium bicarbonate to buffer the rumen. The same apparent digestibility was obtained in the digestibility study using the internal (indigestible ADF) and external (Yb) markers, indicating that the internal marker technique could be applied reliably in the lactation trials. Apparent digestibilities determined in the four lactation trials for the 60% forage diets only are in Table 2. Overall, maceration improved apparent digestibility of DM but especially of OM; trends of about a one percentage unit of improved digestibility of fiber and CP were not significant.

Although maceration significantly increased ($P < 0.05$) DM intake in two out of four lactation trials, this trend was not significant overall (Table 4). There was no effect of diet on BW gain. However, the most milk

Table 1. Mean composition of macerated and non-macerated (control) alfalfa silage.[1]

Component	Control	Macerated	SEM[2]	$P > F$[3]
CP, %	20.9	20.6	0.3	0.35
pH	5.00	4.88	0.07	0.27
Ash, %	10.2	11.2	0.2	0.03
NDF, %	43.3	44.6	0.5	0.05
ADF, %	34.5	35.6	0.4	0.06
NPN, %	44.0	40.3	1.4	0.06

[1]Alfalfa harvested at one maturity during each of three cuttings in 1996, and harvested at two maturities during first cutting and one maturity during second cutting in 1997.
[2]SEM = Standard error of the mean.
[3]Probability of a significant effect of maceration.

was produced on the Positive Control diet and milk yield also was greater on Macerated than Control alfalfa silage. Despite these highly significant effects on milk yield, there were no differences in FCM because of the decline in milk fat content with increased dietary concentrate (Table 4). That milk fat content on Macerated diet was intermediate between the Negative and Positive Controls suggested that some alteration in ruminal VFA patterns may have occurred with the feeding of Macerated alfalfa. However, ruminal sampling done during the trials conducted using alfalfa harvested in 1996 showed no differences in ruminal VFA between the two diets with 60% forage (data not shown). There were no differences due to diet in milk content of protein, lactose and SNF. However, the overall pattern of significance among diets in yields of protein, lactose and SNF was the same as for milk: Greatest on Positive Control, intermediate on Macerated and lowest on Negative Control (Table 4). Maceration increased yields of milk, protein, lactose and SNF all by about 4% over the Negative Control. Over all four trials, there was a clear advantage to feeding Macerated alfalfa versus Control alfalfa silage.

Overall weighted means (Table 4) from the four lactation trials were used to estimate how much maceration increased NEL content of alfalfa silage. The NEL requirements for maintenance (using mean BW) and BW gain were computed based on NRC (1989) values; NEL requirements for milk production were computed from both composition and yield (Table 5). After deducting the NEL estimated to come from the concentrate portion of each diet, dividing the remaining NEL by OM intakes from alfalfa silage yielded estimates of the NEL contents of Control and Macerated forages. Based on these computations, Macerated alfalfa silage fed in these trials had 4.5% greater NEL per unit OM than did Control alfalfa silage.

Summary and Conclusion

Compared to Control, macerating alfalfa immediately after cutting using a maceration-mat machine depressed NPN content when ensiled; however, Macerated alfalfa harvested using our methods had elevated ash and fiber content versus Control. Apparent digestibility of DM and OM was increased by maceration; trends for increased fiber digestibility were not significant. Over the course of four lactation trials, yield of milk, protein, lactose and SNF each was increased by about 4% on Macerated alfalfa silage over that produced feeding equal amounts of Control alfalfa. There was a reduction in milk fat content with Maceration of alfalfa; milk fat content was intermediate on Macerated alfalfa between the Negative and Positive Controls. The NEL content of the OM in Macerated alfalfa silage was increased by about 5% over Control. Maceration improves the nutritive value of alfalfa silage for lactating dairy cows.

Table 2. Mean composition of diets fed during lactation trials.[1]

Ingredient	Negative Control	Macerated	Positive Control
		(% of DM)	
Control alfalfa silage	60.6	0	49.7
Macerated alfalfa silage	0	60.5	0
Processed high moisture corn	34.5	34.6	41.5
Solvent soybean meal	1.0	1.0	4.6
Roasted soybeans	0.8	0.8	0.8
Low-solubles fish meal	2.4	2.4	2.4
Sodium bicarbonate	0	0	0.40
Dicalcium phosphate	0.28	0.28	0.22
Trace mineral salt (+ Se)[2]	0.30	0.30	0.30
Potassium magnesium sulfate[3]	0.04	0.04	0.04
Vitamin ADE concentrate[4]	0.10	0.10	0.10
Composition (DM basis)			
CP, %	18.0	17.8	18.1
NDF, %	30.8	31.6	27.4

[1]Mean compositions of rations fed in five lactation studies using Control and Macerated alfalfa silage harvested during two cuttings each in 1996 and 1997.
[2]Provided (/kg of DM): Mn, 27 mg; Zn, 27 mg; Fe, 17 mg; Cu, 7 mg; I, 0.40 mg; Se, 0.30 mg; and Co, 0.10 mg.
[3]Provided (/kg of DM): Mg, 110 mg; K, 180 mg; S, 220 mg.
[4]Provided (/kg of DM): vitamin A, 3880 IU; vitamin D, 730 IU; and vitamin E, 0.73 IU.

Table 3. Effect of macerating alfalfa silage on apparent digestibility of nutrients in diets containing about 60% forage.[1]

Nutrient	Control (60.6%)[2]	Macerated (60.5%)[2]	SEM[3]	$P > F$[4]
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DM	60.0	61.1	0.4	0.08
OM	61.9	63.8	0.4	< 0.01
NDF	44.2	45.0	0.6	0.17
ADF	37.9	38.8	0.5	0.32
CP	53.0	54.4	0.7	0.31

[1]Apparent digestibility was estimated using indigestible ADF as an internal marker.
[2]Mean proportion DM from either Control or Macerated alfalfa silage during the four trials.
[3]SEM = Standard error of the mean.
[4]Probability of a significant effect of maceration.

Table 4. Mean performance data from feeding Control or Macerated alfalfa silage to lactating cows.[1]

	Diet[2]				
Item	Negative Control	Macerated	Positive Control	SEM[3]	$P > F^4$
DM intake, kg/d	25.8	26.3	26.3	0.8	0.82
BW change, kg/d	0.38	0.50	0.35	0.20	0.38
Milk, kg/d	36.8[c]	38.2[b]	40.4[a]	0.9	< 0.01
3.5% FCM, kg/d	36.4	37.1	38.4	1.1	0.79
Fat, %	3.50[a]	3.41[b]	3.30[c]	0.12	< 0.01
Fat, kg/d	1.27[b]	1.28[ab]	1.30[a]	0.05	0.04
Protein, %	3.18	3.19	3.32	0.05	0.24
Protein, kg/d	1.16[c]	1.20[b]	1.32[a]	0.03	< 0.01
Lactose, %	4.77	4.80	4.82	0.04	0.59
Lactose, kg/d	1.75[c]	1.83[b]	1.93[a]	0.05	< 0.01
SNF, %	8.66	8.71	8.85	0.09	0.47
SNF, kg/d	3.17[c]	3.30[b]	3.53[a]	0.09	< 0.01
Milk yield : DMI	1.45[b]	1.46[b]	1.55[a]	0.06	0.02

[a,b,c]Means in rows with different superscripts differ ($P < 0.05$).

[1]Mean performance data from five lactation trials weighted for the number of cows in each trial.

[2]Diets contained on average: Negative Control (60.6% Control alfalfa silage); Macerated 60.5% Macerated alfalfa silage); and Positive Control (49.7% Control alfalfa silage).

[3]SEM = Standard error of the mean.

[4]Probability of a significant effect of diet.

Table 5. Effect of maceration on NEL contents of alfalfa silage (AS) estimated from intake and performance data.[1]

	Diet[2]		
Component	Negative Control	Macerated	Positive Control
Maintenance (638 kg), Mcal/d	10.2	10.2	10.2
BW gain, Mcal/d	1.9	2.5	1.8
Milk (composition), Mcal/d	25.8	26.6	28.0
NEL Requirement, Mcal/d	37.9	39.3	39.9
Total DM intake, kg/d	25.7	26.2	26.2
Concentrate DM intake, kg/d	10.2	10.4	13.2
Concentrate NEL,[3] Mcal/d	18.9	19.3	24.5
NEL from AS, Mcal/d	19.0	20.0	15.3
AS DM intake, kg/d	15.5	15.8	13.0
AS NEL, Mcal/kg DM	1.22	1.26	1.18
AS OM intake, kg/d	14.0	14.1	11.7
AS NEL, Mcal/kg OM	1.36	1.42	1.31
Macerated/Control, %	104.5		108.2

[1]Mean performance data from the four lactation trials was weighted for the number of cows in each trial.

[2]Diets contained on average: Negative Control (60.6% Control alfalfa silage); Macerated 60.5% Macerated alfalfa silage); and Positive Control (49.7% Control alfalfa silage).

[3]Mean NEL content of the concentrate portion of the three diets was computed to be 1.86 Mcal/kg DM from NRC (1989) tables.